

# Occupational Exposures and the Risk of Ovarian Cancer in Sweden

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**Background** *Studies of occupational exposures and ovarian cancer, often limited by few subjects or proportionate mortality data, have yielded inconsistent results.*

**Methods** *Swedish women employed in 1960, 1970, or during both years were followed from 1971 to 1989 using census data linked to nationwide cancer and death registries. A total of 9,591 ovarian cancer cases were identified among 1,670,517 women. Poisson regression was used to estimate the relative risk of ovarian cancer in specific occupational groups and in women exposed to particular occupational exposures defined by job exposure matrices. We lacked data on reproductive factors.*

**Results** *Jobs associated with elevated ovarian cancer rates in this and previous studies include dry cleaning, telegraph and telephone work, paper packaging, and graphic and printing work. In contrast to results of some previous studies, we found that hairdressers and beauticians were not at increased risk of ovarian cancer. Organic dusts, aromatic amines, aliphatic and aromatic hydrocarbons are suggested as specific etiologic agents.*

**Conclusions** *In this large study, we have confirmed some results from smaller studies and identified some new relationships that need to be confirmed elsewhere.* Am. J. Ind. Med. 42:200–213, 2002. Published 2002 Wiley-Liss, Inc.<sup>†</sup>

**KEY WORDS:** ovary; cancer; occupation; job exposure matrix; risk factors; relative risk

## INTRODUCTION

Worldwide, ovarian cancer is the sixth most common cancer in females, comprising an estimated 165,000 new cases and 101,000 deaths annually [Parkin et al., 1999; Pisani

et al., 1999]. Pregnancy, oral contraceptive use, hysterectomy, and tubal ligation have been consistently associated with a decreased risk of ovarian cancer, while a history of infertility, and a family history of ovarian or breast cancer have been associated with an elevated risk [Cramer et al., 1983; Franceschi et al., 1991; Negri et al., 1991; Whittemore et al., 1992]. Other reproductive factors, diet, and occupational exposures have been less consistently associated with ovarian cancer risk [Weiss et al., 1996; Shen et al., 1998].

Epidemiologic studies of occupational and environmental exposures and the risk of ovarian cancer have recently been summarized [Shen et al., 1998]. Generally, the results of occupational studies have been inconsistent or insufficient to draw firm conclusions about the risk of ovarian cancer associated with such exposures. Limitations in the published data include a lack of power to detect associations in some occupational groups, the absence of data for potential confounders, and the possibility that increased risks, perhaps found by chance, are preferentially reported and published.

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We present the results of a large study of ovarian cancer and occupation in the Swedish population. Using the nationwide, population-based Swedish Cancer Environment Register (CER III) [National Board of Health and Welfare, 1994], we screened all occupations and industries in Sweden to look for associations with the risk of ovarian cancer. A summary of CER III data has been published previously in a monograph of cancer and occupation in Sweden [Pollan and Gustavsson, 1999]. We further explored whether the risk of ovarian cancer was associated with specific occupational exposures using job exposure matrices (JEM) based on job titles and industries.

## METHODS

### Description of Data

This data linkage has been described previously [Moradi et al., 1998; Adami et al., 1999; Gridley et al., 1999]. Briefly, the Swedish National Population and Housing census has mailed a questionnaire to every Swedish household in the population approximately every 5 years since 1960. Information about place of birth, home and work addresses, employment status, job title, and industry was obtained for each household member [Official Statistics of Sweden, 1975], and identified by a unique personal identifier called the national registration number. Response to the census is required by law, and censuses are estimated to be 99% complete for the entire Swedish population [Moradi et al., 1998]. The “background” register of all women, 3,311,460 who took part in both the 1960 and 1970 censuses was linked to the Swedish Register of Causes of Death [Statistics Sweden, 1989], which provided the dates of death occurring from January 1, 1971 through December 31, 1989 for all Swedish residents.

Since 1958, the Swedish Cancer Register has received reports of all incident malignant tumors diagnosed in Sweden. Reporting by both diagnosing physicians and pathologists is mandatory, resulting in registration of more than 98% of all tumors, with histologic verification of 97% of the tumors [Swedish Cancer Register, 1998]. During the years of follow-up for this study, the International Classification of Disease, seventh revision (ICD-7) was used to classify incident cancers, including ovarian cancer (ICD-7 = 175). The Cancer Environment Register III (CER III) links the Swedish Cancer register for the years 1971–1989 to the national population censuses from both 1960 and 1970, using national registration numbers, to obtain cancer diagnoses [National Board of Health and Welfare, 1994].

To produce a comprehensive analytic file, the CER III register was merged on all data fields (dates, residence, occupation, and industry) to the “background” register described above, which contained census data and dates of death. The final analytic file for this study was then restricted

to women that participated in both the 1960 and 1970 censuses who were gainfully employed in 1960 or 1970, so that housewives were excluded. Follow-up began from January 1, 1971 and continued until diagnosis of cancer, death, or end of follow-up on December 31, 1989. A total of 9,591 cases of ovarian cancer were identified among 1,670,517 women followed for 29,271,346 woman-years.

### Exposure Classification

Three-digit standard occupational codes were used to classify occupations from the 1960 and 1970 censuses into 245 and 248 categories, respectively, and industries from 1970 were recoded to correspond to 1960 3-digit codes (MD) so that both years were classified according to the 1960 three-digit standard industrial codes [Official Statistics of Sweden, 1971]. We surveyed all of the occupations and industries in which women reported employment. To allow examination of some occupations and industries with few women, an experienced occupational hygienist (MD) combined 3-digit categories of occupations or industries with similar exposures. Only those occupational and industrial groups with at least 20 ovarian cancer cases are presented so that occupational exposure can be further classified by year, separating the women into three groups: those employed in 1970 only, those employed in 1960 only, and those employed in both years. This allowed us to explore whether the duration of exposure was important. We assumed that women employed in the same job during both the 1960 and 1970 censuses were likely employed there throughout the 10-year interval, thus indicating long-term exposure to that job. Women employed in 1970 only had the most recent exposures, and may have had less time since their occupational exposure to develop occupationally associated ovarian cancer.

One of the authors (MD) performed an occupational exposure assessment to classify each occupation and industry according to the estimated exposure to solvents, ionizing radiation, asbestos, and diesel. Exposure to electromagnetic fields (EMF) was assessed by a Swedish hygienist as previously described [Floderus et al., 1999]. Each JEM classified exposures into three levels of probability (low, medium, and high) and three levels of intensity (low, medium, and high). Each possible combination of intensity and probability was analyzed as a separate category. When categories contained few cases, groups with probability level 3 were combined with groups with probability level 4. Some women employed in both 1960 and 1970 were exposed to different levels of intensity or probability at the time of each census. When this occurred, the woman was assigned a level of exposure called “unstable” that was analyzed as a separate category.

Exposure to pesticides was first characterized as continuous low-level exposure or short-term high-level exposure (peak) by one of the authors (NP). For women that worked in only 1960 or only 1970, continuous exposures were

categorized as “low” and peak exposures were categorized as “medium.” For women who worked in both 1960 and 1970, continuous and peak exposures were combined into four levels. Continuous exposure to pesticides at the time of only one census, with no exposure at the time of the other census, was classified as “low.” “Medium” exposures were assigned to women exposed to peak exposures at one census and unexposed at the other census, or to women exposed to continuous levels at both censuses. Continuous exposure at one census and peak exposure at the other was classified as “medium/high,” while exposure to peak levels at both censuses was called “high.”

Three Swedish specialists in occupational medicine assigned physical activity levels of sedentary (S), light (L), medium (M), heavy (H), and very heavy (V) for each occupation, as previously described [Moradi et al., 1998]. Only those occupations that were consistently classified by the three experts, 83% of occupations, are included in analyses. Women that worked in both 1960 and 1970 were assigned levels based on exposure during both years, regardless of which year each exposure was recorded (SS, SL, S = sedentary; LL, SM, SH, L = light; MM, LM, LH, LV, M = medium; HH, MH, H = heavy; MV, HV, VV, V = very heavy). Because there were few women working in jobs with very heavy physical activity, the two highest categories of physical activity were combined for analysis.

Five levels of socioeconomic status (skilled/unskilled and lowest to highest education) were estimated based on a woman's job title as previously described [Statistics Sweden, 1995]. Residence in the three largest cities in Sweden (Stockholm, Gothenburg, and Malmö) was classified as “urban,” while residence in the rest of Sweden was classified as “non-urban.” For women that worked in both 1960 and 1970, those whose socioeconomic status or residence differed at the two censuses were assigned the value from the 1960 census. Exposure to sunlight was estimated based on latitude of county of residence (most Northern, North and middle, South and middle, and most Southern) and on probable location of work (indoor, outdoor, or both) [Adami et al., 1999].

## Analysis

The relative risk of ovarian cancer associated with various occupations and industries specified by 3-digit codes, or with various occupational exposures, was calculated by Poisson regression using Epicure software [Preston et al., 1988]. For all analyses, the data were stratified by time categories based on the census when employment was reported (1960 only, 1970 only, or during both 1960 and 1970), so that the risk of ovarian cancer for a specific occupational group was calculated relative to all other women that reported employment in the same time period. The baseline model had cases and person-years tabulated

within fourteen 5-year-age intervals ( $< 25$ ,  $25-29$ , ...,  $\geq 85$ ) based on the subject's attained age during follow-up and included only gainfully employed women. Analyses of occupational and industrial groups were adjusted only for attained age. The addition of calendar time to the models did not substantially change any of the reported estimates. In analyses of specific occupational exposures using JEM, all other exposure variables were considered as potentially confounding variables and were retained in the regression model, if they changed the relative risk estimate of interest by more than 10%.

## RESULTS

Multiple occupations and industries were surveyed perhaps leading to chance findings, and findings were stratified by time of reported employment (1970 only, 1960 only, or during both years) thus decreasing power to detect significant associations between ever work in specific jobs and ovarian cancer risk. Therefore, here we highlight relative risks of 1.5 or greater or 0.5 or less from Tables I–III, regardless of statistical significance. Risks of lower magnitude are shown in Tables I–III. Relative risk estimates with 95% CI excluding 1.0 are highlighted in bold type.

The age-adjusted risks of ovarian cancer for women employed in specific occupations relative to all other women who reported employment are presented in Table I. Long-term exposure to some occupations appeared to influence the risk of ovarian cancer as significantly elevated risks of ovarian cancer in specific occupations were observed most frequently in women that reported working in specific occupations during both 1960 and 1970. Statistically significant, 50% or greater increases in the risk of ovarian cancer were noted for engineers and technicians in mechanical, chemical, and other technical fields, religious workers, pictorial artists, designers or decorators, technical and scientific workers, social workers, psychologists, personnel directors, shoe workers, graphic workers, chocolate and candy workers, paper and packaging workers, wrapping, packaging, dock, warehouse and supply room workers, and clothes pressers relative to other women that reported employment in the same time category. A 50% or greater increase in risk was also suggested for chemical and cellulose workers, general social administrative workers, computer operators, and fine mechanical workers, but the associations failed to reach statistical significance.

Age-adjusted relative risks of ovarian cancer associated with employment in specific industries are listed in Table II. As with occupational exposures, industrial exposures for women that worked in both 1960 and 1970 were more likely to be associated with relatively high rates of ovarian cancer than exposures reported during one census only, indicating that long-term exposures may be important. A significant increase in the risk of ovarian cancer of 50% or more relative

**TABLE I.** Relative Risk of Ovarian Cancer Associated With Work in Various Occupations

Code	Occupation	1970 only			1960 only			1960 and 1970		
		N	RR <sup>a</sup>	95% CI	N	RR <sup>a</sup>	95% CI	N	RR <sup>a</sup>	95% CI
001–009	Technical work	29	1.02	0.7–1.5	41	0.92	0.7–1.3	24	<b>1.87</b>	<b>1.3–2.8</b>
003,004 006,008	Engineers and technicians with mechanical jobs; Engineers and technicians with chemical engineering jobs; Engineers and technicians in other technical fields; technical assistants	22	0.94	0.6–1.4	42	0.95	0.7–1.3	20	<b>2.05</b>	<b>1.3–3.2</b>
010–019	Work in chemistry and physics	22	0.78	0.5–1.2	3	1.78	0.6–5.5	0		
011,014	Chemists; lab technicians	21	0.78	0.5–1.2	1	0.75	0.1–5.3	0		
040–049	Health and medical service	451	<b>0.89</b>	<b>0.8–0.97</b>	208	0.95	0.8–1.1	261	0.88	0.8–1.00
040,041	Nursing; midwife	75	0.99	0.8–1.2	71	1.00	0.8–1.3	79	0.94	0.8–1.2
042,047	Guardians in mental wards; physical therapists, masseurs/masseuses, etc.	47	0.87	0.7–1.2	19	0.79	0.5–1.2	28	1.11	0.8–1.6
043	Medical assistants	331	<b>0.88</b>	<b>0.8–0.98</b>	115	0.89	0.7–1.1	103	0.89	0.7–1.1
044	Dental assistants	13	0.74	0.4–1.3	17	1.13	0.7–1.8	10	0.70	0.4–1.3
045	X-ray assistants; medical laboratory technicians, etc.	13	0.67	0.4–1.2	18	0.98	0.6–1.6	1	0.21	0.03–1.5
050–059	Education	138	<b>0.78</b>	<b>0.7–0.9</b>	112	1.05	0.9–1.3	204	1.02	0.9–1.2
051,052,053	Teachers at universities and schools of higher learning; teachers for special disciplines; class teachers	78	0.83	0.7–1.03	84	1.07	0.9–1.3	147	1.05	0.9–1.2
054,055,056	Trainers; vocational teachers; preschool teachers	55	<b>0.76</b>	<b>0.6–0.99</b>	36	1.02	0.7–1.4	44	0.97	0.7–1.3
060–069	Religious work	12	<b>2.46</b>	<b>1.4–4.3</b>	6	0.72	0.3–1.6	5	1.21	0.5–2.9
080–089	Literary and artistic work	24	0.84	0.6–1.3	20	1.32	0.9–2.0	17	1.19	0.7–1.9
081,082,083	Pictorial artists; designers; decorators	8	0.73	0.4–1.5	13	<b>1.80</b>	<b>1.1–3.1</b>	4	1.45	0.7–2.9
085,086,088	Journalists, editors; scenic artists; other literary and artistic work	11	0.77	0.4–1.4	5	0.75	0.3–1.8	7	1.01	0.5–2.1
090–099	Other technical and scientific work, etc.	101	1.07	0.9–1.3	46	<b>1.50</b>	<b>1.1–2.0</b>	40	<b>1.39</b>	<b>1.02–1.9</b>
091,096,098	Accountants and auditors; personnel person; other pertinent work	22	0.79	0.5–1.2	5	1.38	0.6–3.3	0		
092,095	Social workers; psychologists, personnel directors	50	1.18	0.9–1.6	32	<b>1.42</b>	<b>1.01–2.0</b>	26	<b>1.60</b>	<b>1.1–2.4</b>
093	Librarians, archivists, curators	32	1.36	0.96–1.9	11	1.40	0.8–2.5	10	1.33	0.7–2.5
100–109	General social administrative work	26	1.05	0.7–1.5	7	1.28	0.6–2.7	7	1.88	0.9–3.9
110–119	Business administration and other technical and economical administrative work	53	1.19	0.9–1.6	29	1.22	0.9–1.8	6	0.97	0.4–2.2
200–209	Bookkeeping and cashier work	236	0.96	0.9–1.1	184	1.02	0.9–1.2	108	1.18	0.97–1.4
201,203	Bookkeepers and office cashiers; bank cashiers	175	0.99	0.9–1.2	154	1.04	0.9–1.2	85	1.21	0.98–1.5
204	Shop and restaurant cashiers	69	0.91	0.7–1.2	38	0.97	0.7–1.3	15	1.12	0.7–1.9
290–299	Stenographic, typing, and other office work	657	1.02	0.9–1.1	408	1.05	0.95–1.2	386	<b>1.13</b>	<b>1.02–1.3</b>
290	Secretaries, stenographers, typists	190	0.96	0.8–1.1	193	1.08	0.9–1.3	98	1.15	0.9–1.4
291	Computer operators	33	1.11	0.8–1.6	17	1.52	0.9–2.4	10	1.62	0.9–3.0
292,293, 295,296, 297,298	Bank clerks; travel agency clerks; administrators of real estate and commodities; insurance clerks; health insurance clerks; special office workers, etc.	74	1.03	0.8–1.3	241	1.12	0.98–1.3	33	1.16	0.8–1.6
299	Unspecifiable jobs	545	1.07	0.98–1.2	142	0.99	0.8–1.2	58	0.94	0.7–1.2

**TABLE I.** (Continued)

Code	Occupation	1970 only			1960 only			1960 and 1970		
		N	RR <sup>a</sup>	95% CI	N	RR <sup>a</sup>	95% CI	N	RR <sup>a</sup>	95% CI
300–309	Wholesale and retail business people	58	1.15	0.9–1.5	69	0.92	0.7–1.2	33	1.04	0.7–1.5
550–559	Other commercial work	596	1.03	0.95–1.1	508	1.08	0.99–1.2	341	1.10	0.99–1.2
331, 333	Purchasers, office sales people; other business personnel	578	1.04	0.96–1.1	482	1.08	0.98–1.2	299	1.13	1.00–1.3
332	Heads of businesses	30	0.80	0.6–1.1	54	1.05	0.8–1.4	10	0.90	0.5–1.7
338	Gasoline sellers, demonstrators, etc.	20	1.03	0.7–1.6	4	1.27	0.5–3.4	0		
400–409	Agricultural, forest, and garden/park management	29	1.02	0.7–1.5	43	0.95	0.7–1.3	10	1.01	0.5–1.9
410–419	Agriculture, horticulture, animal management	298	<b>0.89</b>	<b>0.8–0.99</b>	144	1.08	0.9–1.3	48	1.05	0.8–1.4
411, 412	Farmers (employed workers, agricultural worker); gardeners (employed)	262	0.89	0.8–1.01	126	1.09	0.9–1.3	44	1.19	0.9–1.6
413	Pet keepers	38	0.84	0.6–1.2	22	0.98	0.7–1.5	0		
630–639	Locomotive engineers, railroad conductors, traffic controllers, and highway workers	27	0.70	0.5–1.02	15	0.97	0.6–1.6	9	1.42	0.7–2.7
650–659	Post office and telecommunications	83	0.90	0.7–1.1	102	0.89	0.7–1.1	85	1.05	0.8–1.3
651, 655	Post office assistants, dispatchers, etc.; telegraph dispatchers, radio dispatchers	35	0.89	0.6–1.3	26	1.03	0.7–1.5	34	1.15	0.8–1.6
653, 654	Telephone operators (National Telecommunications Administration); switchboard operators	52	0.94	0.7–1.2	80	0.88	0.7–1.1	47	0.96	0.7–1.3
660–669	Postal and other messenger work	25	0.78	0.5–1.2	7	0.96	0.5–2.0	1	0.38	0.1–2.7
700–709	Textile work	25	0.86	0.6–1.3	75	0.89	0.7–1.1	39	<b>1.43</b>	<b>1.1–2.0</b>
710–719	Sewing	131	1.08	0.9–1.3	244	1.01	0.9–1.2	123	0.98	0.8–1.2
711, 715, 716	Tailors, shop seamstresses, etc.; tailors, cutters, etc.; makers of ready-made garments	100	1.05	0.9–1.3	215	1.01	0.9–1.2	99	0.99	0.8–1.2
713, 718	Milliners and haberdashers; other sewing work	34	1.06	0.8–1.5	34	0.90	0.6–1.3	10	0.94	0.5–1.8
720–729	Shoe and leather work	8	0.62	0.3–1.3	31	1.07	0.8–1.5	12	1.42	0.8–2.5
722	Shoeworkers	4	0.57	0.2–1.5	23	1.00	0.7–1.5	11	<b>1.82</b>	<b>1.01–3.3</b>
740–749	Fine mechanical work	7	1.15	0.6–2.4	9	1.78	0.9–3.4	6	1.71	0.8–3.8
750–759	Shop and construction metal workers	89	1.11	0.9–1.4	50	1.09	0.8–1.4	16	0.81	0.5–1.3
750	Workshop mechanics (bench and machine workers)	50	1.30	0.98–1.7	10	0.85	0.5–1.6	4	1.14	0.4–3.5
751, 758	Installers and machine assemblers; other shop and metal industry work	41	0.93	0.7–1.3	37	0.95	0.7–1.3	6	0.71	0.3–1.6
760–769	Electrical work	39	0.99	0.7–1.4	35	1.19	0.9–1.7	16	1.42	0.9–2.3
770–779	Woodworking	15	0.73	0.4–1.2	6	0.88	0.4–2.0	4	1.62	0.6–4.3
800–809	Graphic work	27	0.98	0.7–1.4	26	1.08	0.7–1.6	20	<b>1.58</b>	<b>1.02–2.5</b>
801, 808	Typographers, lithographers, etc.; other graphic work	16	1.21	0.7–2.0	8	1.08	0.5–2.2	3	1.59	0.5–4.9
806	Bookbinders	14	0.90	0.5–1.5	20	1.12	0.7–1.7	14	1.48	0.9–2.5
820–829	Food-related work	48	0.75	0.6–1.00	75	1.06	0.9–1.3	35	<b>1.41</b>	<b>1.01–2.0</b>
822	Bakers and confectioners	18	0.87	0.6–1.4	36	1.25	0.9–1.7	12	1.18	0.7–2.1
823	Chocolate and candy workers	6	1.09	0.5–2.4	12	1.61	0.9–2.8	5	<b>2.79</b>	<b>1.2–6.7</b>
825	Food processors	10	0.62	0.3–1.2	19	1.12	0.7–1.8	7	1.05	0.5–2.2
830–839	Chemical and cellulose workers	20	0.94	0.6–1.5	16	0.82	0.5–1.4	12	1.52	0.9–2.7
836, 839	Paper, cardboard, and fiberboard workers; unspecifiable jobs	17	1.04	0.7–1.7	12	0.72	0.4–1.3	8	1.21	0.6–2.4

TABLE I. (Continued)

Code	Occupation	1970 only			1960 only			1960 and 1970		
		N	RR <sup>a</sup>	95% CI	N	RR <sup>a</sup>	95% CI	N	RR <sup>a</sup>	95% CI
850–859	Other fabrication work	44	0.78	0.6–1.1	42	0.95	0.7–1.3	17	1.23	0.8–2.0
851, 852	Rubber product workers; plastic product workers	26	0.84	0.6–1.2	11	0.71	0.4–1.3	5	0.97	0.4–2.3
857	Paper and packaging workers	6	0.62	0.3–1.4	13	1.13	0.7–2.0	8	<b>2.16</b>	<b>1.1–4.3</b>
858	Other fabrication work	9	0.75	0.4–1.4	15	1.04	0.6–1.7	1	0.45	0.1–3.2
860–869	Heavy and miscellaneous labor	16	1.43	0.9–2.3	24	1.26	0.9–1.9	1	1.30	0.2–9.3
880–889	Wrapping, packaging, dock, warehouse, and supply room work	105	0.93	0.8–1.1	90	1.02	0.8–1.3	34	<b>1.53</b>	<b>1.1–2.1</b>
881	Packagers and wrappers	55	0.84	0.7–1.1	59	1.04	0.8–1.3	14	1.29	0.8–2.2
883	Warehouse and supply room workers	57	1.11	0.9–1.4	38	1.08	0.8–1.5	13	1.65	0.96–2.8
910–919	Domestic work, porter work, etc.	772	1.00	0.9–1.1	493	0.97	0.9–1.1	233	1.11	0.97–1.3
911	Economic managers	58	1.09	0.8–1.4	57	0.96	0.7–1.3	24	0.96	0.6–1.4
912	Cooks and cold buffet managers	70	1.14	0.9–1.5	60	1.05	0.8–1.4	41	<b>1.37</b>	<b>1.01–1.9</b>
913	Kitchen assistants	194	0.90	0.8–1.04	86	0.91	0.7–1.1	35	1.21	0.9–1.7
914	Domestics and governesses	136	0.88	0.8–1.1	296	0.97	0.9–1.1	38	1.05	0.8–1.4
915	Custodians, etc.	363	1.06	0.96–1.2	48	1.16	0.9–1.5	29	1.11	0.8–1.6
916, 917, 918	Hotel porters; pursers, parking attendants, etc.; other domestic work	14	1.14	0.7–1.9	9	0.68	0.4–1.3	3	1.80	0.6–5.6
920–929	Waiting on tables	146	0.99	0.8–1.2	137	1.08	0.9–1.3	59	1.06	0.8–1.4
930–939	Caretaking, cleaning work	522	1.05	0.96–1.2	249	1.06	0.9–1.2	118	1.00	0.8–1.2
931	Caretakers, etc.	22	1.04	0.7–1.6	10	0.73	0.4–1.4	2	0.61	0.2–2.4
932	Cleaners	503	1.05	0.96–1.1	242	1.08	0.95–1.2	113	1.02	0.8–1.2
940–949	Other service work	88	0.90	0.7–1.1	133	1.03	0.9–1.2	79	1.08	0.9–1.3
941	Barbers, beauticians, etc.	14	<b>0.56</b>	<b>0.3–0.9</b>	36	0.87	0.6–1.2	51	1.21	0.9–1.6
942, 948	Bath house workers; other service work	25	0.93	0.6–1.4	11	1.11	0.6–2.0	2	0.50	0.1–2.0
943	Laundry workers	33	0.96	0.7–1.4	65	<b>1.33</b>	<b>1.04–1.7</b>	12	0.82	0.5–1.5
944	Clothes pressing	16	<b>1.71</b>	<b>1.1–2.8</b>	24	0.87	0.6–1.3	5	0.73	0.3–1.8

<sup>a</sup>Relative risk adjusted for 5-year age group.

to workers in other industries was noted for workers in mining and ore processing, dairies, condensed milk plants and ice cream preparation, sawmills and planing mills, construction, carpentry and other lumber industries, paper packaging and other paper, soap, perfume, and lipstick plants, wholesale food, and wholesale building materials industries.

The gardening, sugar, chocolate and candy, unspecified garment, rubber, miscellaneous fabrication, scientific and surgical instrument construction, wholesale fuels, chemical and other products, water travel, police work, patent, engineering and architect industries were associated with greater than 50% elevations in ovarian cancer incidence, but the associations failed to reach statistical significance. Show business, hair cutting, and beauty salons were associated with 50% or greater reductions in risk.

Occupational exposure to EMF (29.7% exposed), diesel (6.2% exposed), and sunlight (47.3% residence in the South, 11.5% occupation outdoor at least part of the time), and socioeconomic status were unrelated to the risk of ovarian cancer (data not shown). Too few women were occupationally exposed to asbestos and ionizing radiation to assess whether these exposures were related to ovarian cancer risk. As shown in Table III, occupational physical activity and exposure to solvents were not associated with the risk of ovarian cancer. The relationship between exposure to pesticides and the risk of ovarian cancer was unclear as women that were exposed to low or medium levels in 1960 only or 1970 only were at increased risk of ovarian cancer, but women that were exposed to low or medium levels during both 1960 and 1970 were at decreased risk of ovarian cancer. Residence in an urban county was associated with ovarian

**TABLE II.** Relative Risk of Ovarian Cancer Associated With Work in Various Industries

Code	Industry	1970 only			1960 only			1960 and 1970		
		N	RR <sup>a</sup>	95% CI	N	RR <sup>a</sup>	95% CI	N	RR <sup>a</sup>	95% CI
010–019	Agriculture	333	0.93	0.8–1.03	186	1.07	0.9–1.2	64	1.00	0.8–1.3
010	Actual agriculture and stock raising	295	0.92	0.8–1.03	152	1.04	0.9–1.2	46	0.91	0.7–1.2
011	Gardening	36	0.97	0.7–1.4	26	1.30	0.9–1.9	12	1.65	0.9–2.9
020–029	Forestry	13	1.10	0.6–1.9	9	0.94	0.5–1.8	4	1.36	0.5–3.6
100–109	Mining and ore processing	10	1.46	0.8–2.7	7	1.14	0.6–2.4	5	<b>2.95</b>	<b>1.2–7.1</b>
200–209	Food industry	113	0.84	0.7–1.0	196	1.01	0.9–1.2	71	1.15	0.9–1.5
200	Butcher shops, meat processing, and packing plants	20	0.65	0.4–1.0	24	0.97	0.7–1.5	11	1.43	0.8–2.6
201	Dairies, condensed milk plants, and ice cream preparation	6	0.60	0.3–1.3	11	0.74	0.4–1.4	11	<b>2.36</b>	<b>1.3–4.3</b>
202	Fruit and vegetable processing	12	0.80	0.5–1.4	17	1.36	0.8–2.2	2	0.41	0.1–1.6
205	Bakeries and confectionery plants	57	0.99	0.8–1.3	114	1.04	0.9–1.3	25	0.91	0.6–1.4
206, 207	Sugar industry; chocolate and candy industry	11	1.06	0.6–1.9	18	1.00	0.6–1.6	11	1.69	0.9–3.1
210–219	Beverage and tobacco industry	6	0.73	0.3–1.6	17	1.12	0.7–1.8	7	1.35	0.6–2.8
220–229	Textile industry	48	0.98	0.7–1.3	133	1.04	0.9–1.2	58	1.22	0.9–1.6
220	Wool industry	NA			39	1.09	0.8–1.5	NA		
221	Cotton industry	NA			42	1.05	0.8–1.4	NA		
223	Other textile preparation	50	1.14	0.9–1.5	13	0.91	0.5–1.6	5	1.14	0.5–2.7
224	Knitting factories	21	0.98	0.6–1.5	34	0.96	0.7–1.3	20	1.35	0.9–2.1
225, 226, 227	Rope and binder twine plants; handicrafts; other textile industries	10	0.92	0.5–1.7	32	1.20	0.9–1.7	0		
230–239	Garment industry	113	1.05	0.9–1.3	264	1.05	0.9–1.2	96	0.97	0.8–1.2
230	Shoe fabrication from leather and skins	NA			34	1.22	0.9–1.7	NA		
233	Ready-made garment industry	110	1.00	0.8–1.2	173	1.05	0.9–1.2	61	0.89	0.7–1.2
234	Other garment sewing	NA			43	0.96	0.7–1.3	NA		
235	Fur, skin, and glove preparation	NA			23	1.20	0.8–1.8	NA		
237	Other pertinent garment industries	18	1.56	0.98–2.5	7	1.14	0.5–2.4	1	1.86	0.3–13.2
240–249	Lumber industry	29	0.87	0.6–1.3	21	1.37	0.9–2.1	9	1.75	0.9–3.4
240, 241, 247	Sawmills and planing mills; construction carpentry; other lumber industries	9	0.98	0.5–1.9	26	<b>1.86</b>	<b>1.3–2.7</b>	2	1.50	0.4–6.0
250–259	Furniture and furnishing industry	21	0.88	0.6–1.3	15	1.33	0.8–2.2	4	1.05	0.4–2.8
260–269	Paper industry	42	1.02	0.8–1.4	46	1.18	0.9–1.6	26	1.21	0.8–1.8
262	Paper mills and cardboard plants	31	1.37	0.96–1.9	15	0.91	0.6–1.5	11	0.97	0.5–1.8
264, 265	Paper packaging industry; other pertinent industries	5	0.56	0.2–1.4	24	<b>1.54</b>	<b>1.03–2.3</b>	10	<b>2.47</b>	<b>1.3–4.6</b>
270–279	Graphic industry, publishing businesses	90	1.04	0.9–1.3	66	1.01	0.8–1.3	36	1.03	0.8–1.4
270, 271, 272, 274, 275	Newspaper printing shops; book and job printing shops; other graphic industries; newspaper publishers; book publishers	15	1.04	0.6–1.7	79	1.01	0.8–1.3	4	0.84	0.3–2.3
273	Bookbinderies	12	1.20	0.7–2.1	14	1.12	0.7–1.9	4	0.98	0.4–2.6
280–289	Leather industry	8	0.94	0.5–1.9	13	1.21	0.7–2.1	2	0.56	0.1–2.2
300–309	Rubber industry (rubber goods production)	14	1.52	0.9–2.6	18	1.06	0.7–1.7	8	1.03	0.5–2.1
310–319	Chemical industry	63	0.91	0.7–1.2	42	1.00	0.7–1.4	20	1.30	0.8–2.0
311	Plastic factories	25	0.77	0.5–1.1	0			0		
315	Pharmaceutical plants	12	1.19	0.7–2.1	5	0.73	0.3–1.8	3	0.91	0.3–2.8
316, 317	Soap and perfume plants; lipstick plants	6	0.89	0.4–2.0	16	1.13	0.7–1.9	6	<b>2.51</b>	<b>1.1–5.6</b>
330–339	Earth and stone industry	17	0.94	0.6–1.5	18	0.81	0.5–1.3	10	0.94	0.5–1.8
340–349	Metal industry	51	0.88	0.7–1.2	90	1.06	0.9–1.3	14	0.83	0.5–1.4

TABLE II. (Continued)

Code	Industry	1970 only			1960 only			1960 and 1970		
		N	RR <sup>a</sup>	95% CI	N	RR <sup>a</sup>	95% CI	N	RR <sup>a</sup>	95% CI
340, 342	Iron and steel plants; other metal plants	2	0.33	0.1–1.3	31	1.13	0.8–1.6	2	0.94	0.2–3.8
344, 345, 346	Sheet and plate fabrication and copper forging; iron and steel making; other metal manufacturing	49	0.91	0.7–1.2	56	1.01	0.8–1.3	12	0.97	0.6–1.7
350–359	Machine and electronics industry	117	0.85	0.7–1.02	133	0.97	0.8–1.2	77	<b>1.26</b>	<b>1.01–1.6</b>
350	Machine industry	40	<b>0.73</b>	<b>0.5–0.99</b>	76	1.06	0.8–1.3	20	1.15	0.7–1.8
351, 352	Radio and TV Industry; other electronics industry	85	0.93	0.8–1.2	65	0.88	0.7–1.1	49	<b>1.39</b>	<b>1.1–1.9</b>
360–369	Construction of means of transport	77	<b>1.28</b>	<b>1.02–1.6</b>	33	0.93	0.7–1.3	10	1.13	0.6–2.1
363, 364	Automotive plants; automotive repair	56	<b>1.39</b>	<b>1.1–1.8</b>	24	1.00	0.7–1.5	6	1.13	0.5–2.5
370–379	Miscellaneous fabrication industries	62	0.93	0.7–1.2	30	0.82	0.6–1.2	5	1.70	0.7–4.1
370	Scientific and surgical instrument construction	13	1.55	0.9–2.7	9	1.54	0.8–3.0	1	0.92	0.1–6.5
371	Optical instrument and photographic supply manufacture	39	0.99	0.7–1.4	0			0		
400–409	Building and construction business	44	1.00	0.8–1.4	32	1.32	0.9–1.9	7	1.06	0.5–2.2
410–419	Other building and construction business	24	0.81	0.5–1.2	18	0.81	0.5–1.3	2	0.46	0.1–1.8
500–509	Electrical power, gas, and waterworks, etc.	19	1.19	0.8–1.9	7	0.60	0.3–1.3	7	1.11	0.5–2.3
500	Electrical power plants and electricity board	16	1.28	0.8–2.1	5	0.51	0.2–1.2	6	1.10	0.5–2.5
600–609	Wholesale foods, etc.	44	0.82	0.6–1.1	32	0.95	0.7–1.4	16	<b>1.69</b>	<b>1.04–2.8</b>
600, 601	Wholesale produce; other wholesale grocery items	10	1.22	0.7–2.3	42	1.05	0.8–1.4	4	1.94	0.7–5.2
610–619	Wholesaling other than food, etc.	155	1.14	0.97–1.3	70	0.97	0.8–1.2	38	1.37	1.00–1.9
610, 611	Wholesale trade with textiles and garments; wholesale household goods, etc.	26	1.01	0.7–1.5	13	0.70	0.4–1.2	4	1.24	0.5–3.3
612	Wholesale building materials	23	1.02	0.7–1.5	15	0.88	0.5–1.5	9	<b>2.37</b>	<b>1.2–4.6</b>
613	Wholesale fuels	13	1.59	0.9–2.7	11	1.36	0.8–2.5	4	1.44	0.5–3.8
616	Wholesale paper, etc.	3	1.15	0.4–3.6	17	1.46	0.9–2.4	1	2.53	0.4–18.0
617, 618	Wholesale chemical products; other wholesale items and assortments	57	1.20	0.9–1.6	17	1.00	0.6–1.6	7	1.51	0.7–3.2
620–629	Retail trade in primarily foods or the like	377	<b>1.15</b>	<b>1.04–1.3</b>	270	1.08	0.95–1.2	130	1.14	0.96–1.4
620	Food businesses	311	<b>1.22</b>	<b>1.1–1.4</b>	212	1.09	0.95–1.3	97	<b>1.25</b>	<b>1.03–1.5</b>
621	Various village stores and ship stores	NA			54	0.90	0.7–1.2	NA		
623, 624	Wine and liquor businesses; tobacco businesses	90	0.89	0.7–1.1	22	1.11	0.7–1.7	9	0.95	0.5–1.8
630–639	Retail trade in textiles and garments, etc.	146	1.01	0.9–1.2	123	0.93	0.8–1.1	90	1.14	0.9–1.4
630	Ready-made garment business	153	0.95	0.8–1.1	46	0.91	0.7–1.2	45	<b>1.39</b>	<b>1.04–1.9</b>
631	Manufacturing businesses	NA			83	1.06	0.9–1.3	NA		
634	Show rooms	24	1.16	0.8–1.7	8	<b>0.47</b>	<b>0.2–0.9</b>	14	1.49	0.9–2.5
640–649	Retail trade in household goods, etc.	84	1.03	0.8–1.3	33	0.91	0.6–1.3	13	0.80	0.5–1.4
640	Furniture, carpets, and office equipment	47	1.05	0.8–1.4	6	0.79	0.4–1.8	3	0.73	0.2–2.3
643, 644	Radio and appliance businesses; watches, clocks, jewelry, optical instrument, and music businesses	32	0.95	0.7–1.3	8	0.82	0.4–1.6	5	0.96	0.4–2.3
650–659	Retail trade in other branches	69	0.79	0.6–1.0	65	1.01	0.8–1.3	42	0.99	0.7–1.3
652, 653	Book and paper trade; flower shops	26	0.87	0.6–1.3	19	0.89	0.6–1.4	11	0.92	0.5–1.7
655, 656	Perfume and over-the-counter pharmaceutical businesses	30	0.75	0.5–1.1	29	1.31	0.9–1.9	21	0.92	0.6–1.4
660–669	Retail trade in miscellaneous lines, etc.	155	0.86	0.7–1.01	165	1.09	0.9–1.3	48	1.11	0.8–1.5
670–679	Banking and insurance businesses	144	1.15	0.98–1.4	69	1.02	0.8–1.3	73	1.03	0.8–1.3
680–689	Real estate business, etc.	83	1.02	0.8–1.3	24	0.99	0.7–1.5	8	1.22	0.6–2.4



TABLE II. (Continued)

Code	Industry	1970 only			1960 only			1960 and 1970		
		N	RR <sup>a</sup>	95% CI	N	RR <sup>a</sup>	95% CI	N	RR <sup>a</sup>	95% CI
700–709	Transport	52	0.98	0.8–1.3	41	0.94	0.7–1.3	27	1.14	0.8–1.7
700	Railroad traffic	3	0.40	0.1–1.2	15	1.00	0.6–1.7	7	0.78	0.4–1.6
701, 702, 703	Trolley and bus traffic; automobile traffic; other land transport	38	1.13	0.8–1.6	14	0.81	0.5–1.4	11	1.17	0.7–2.1
704, 705, 713, 715	Long-distance travel by water; short-distance travel by water; other water travel activities; dispatching, ship brokering, etc.	12	1.06	0.6–1.9	14	1.20	0.7–2.0	5	2.01	0.8–4.8
710–719	Businesses associated with transport	15	0.80	0.5–1.3	5	0.53	0.2–1.3	2	0.56	0.1–2.2
720–729	Post office and telecommunications	83	0.88	0.7–1.1	96	0.96	0.8–1.2	107	1.18	0.97–1.4
720	Post office	61	0.89	0.7–1.1	36	1.13	0.8–1.6	38	0.97	0.7–1.3
721	Telegraph and telephone	26	0.92	0.6–1.4	64	0.92	0.7–1.2	65	<b>1.32</b>	<b>1.03–1.7</b>
800–809	Administration, data not supplied elsewhere	238	1.00	0.9–1.1	112	1.03	0.9–1.2	114	1.02	0.9–1.2
803	National defense	32	0.86	0.6–1.2	25	0.83	0.6–1.2	25	1.04	0.7–1.5
804	Police work	23	1.51	1.00–2.3	7	0.84	0.4–1.8	8	1.48	0.7–3.0
805, 807, 808	Customs; other state administration; other community administration	202	1.01	0.9–1.2	77	1.11	0.9–1.4	59	0.91	0.7–1.2
810–819	Education	415	0.93	0.9–1.03	213	0.98	0.9–1.1	299	1.04	0.93–1.2
811	State secondary grammar schools, training schools, etc.	147	0.97	0.8–1.1	48	1.12	0.8–1.5	20	0.81	0.5–1.3
812	Elementary and experimental schools	274	0.96	0.9–1.1	159	0.98	0.8–1.2	207	1.08	0.94–1.2
813	Other educational institutions	58	0.87	0.7–1.1	53	1.00	0.8–1.3	8	0.98	0.49–2.0
820	Health care	547	0.91	0.8–1.00	247	0.95	0.8–1.1	331	0.99	0.9–1.1
830–839	Other public institutions	753	1.01	0.9–1.1	205	<b>1.20</b>	<b>1.04–1.4</b>	148	<b>1.20</b>	<b>1.02–1.4</b>
831, 832	Swedish church; other religious societies	27	<b>1.47</b>	<b>1.01–2.1</b>	19	1.19	0.8–1.9	6	0.94	0.4–2.1
834	Social work	655	0.99	0.9–1.1	150	<b>1.21</b>	<b>1.03–1.4</b>	105	1.17	0.96–1.4
835, 837	Professional and trade organizations; other pertinent jobs	33	0.95	0.7–1.3	34	1.40	1.00–2.0	16	1.47	0.9–2.4
836	Libraries and museums	36	1.21	0.9–1.7	6	0.92	0.4–2.0	11	1.34	0.7–2.4
840–849	Public functions	105	0.97	0.8–1.2	55	<b>1.45</b>	<b>1.1–1.9</b>	18	0.93	0.6–1.5
840, 841	Lawyer and other legal work; bookkeeping and auditing	23	1.01	0.7–1.5	14	1.46	0.9–2.5	4	0.71	0.3–1.9
842	Patent, engineering, and architect office	36	0.99	0.7–1.4	13	1.29	0.8–2.2	8	1.53	0.8–3.1
843, 844	Advertising and marketing agencies; typing duplicating and copying bureaus	46	0.96	0.7–1.3	15	1.47	0.9–2.4	1	0.34	0.1–2.4
845	Other pertinent public functions	5	0.71	0.3–1.7	18	1.33	0.8–2.1	0		
850–859	Literary, artistic, and recreational jobs	59	0.97	0.8–1.3	21	0.99	0.6–1.5	8	0.64	0.3–1.3
851, 852, 853	Fine arts and music composition; film industry and cinema houses; theaters	8	0.70	0.4–1.4	13	0.97	0.6–1.7	3	0.57	0.2–1.8
857	Sports and gymnastics	37	0.98	0.7–1.4	1	0.51	0.1–3.6	0		
860–869	Domestic work	57	1.02	0.8–1.3	294	0.98	0.9–1.1	32	1.08	0.8–1.5
860	Domestic work in farm households	NA			46	0.91	0.7–1.2	NA		
861	Domestic work in other households	64	1.00	0.8–1.3	243	0.98	0.9–1.1	25	1.16	0.8–1.7
870–879	Hotel and restaurant work	165	1.01	0.9–1.2	214	1.07	0.9–1.2	105	<b>1.29</b>	<b>1.1–1.6</b>
870, 871	Restaurants; cafes; and tea shops	106	0.94	0.8–1.1	150	1.03	0.9–1.2	57	1.30	1.00–1.7
872, 873	Hotels; boarding houses; and room rental	78	1.17	0.9–1.5	83	1.19	0.95–1.5	29	1.26	0.9–1.8
880–889	Hygiene and various personal services	116	<b>0.83</b>	<b>0.7–0.99</b>	138	1.03	0.9–1.2	82	1.08	0.9–1.4
880	Laundry, ironing, dyeing	42	0.87	0.7–1.2	74	1.15	0.9–1.4	20	0.84	0.5–1.3
881	Hair cutting and beauty salons	12	<b>0.50</b>	<b>0.3–0.9</b>	37	0.88	0.6–1.2	52	1.26	0.96–1.7

**TABLE II.** (Continued)

Code	Industry	1970 only			1960 only			1960 and 1970		
		N	RR <sup>a</sup>	95% CI	N	RR <sup>a</sup>	95% CI	N	RR <sup>a</sup>	95% CI
882	Photography studios	8	1.11	0.6–2.2	8	1.05	0.5–2.1	4	1.30	0.5–3.5
885	Floor waxing, window washing, disinfecting, etc.	51	0.97	0.7–1.3	14	1.17	0.7–2.0	3	1.14	0.4–3.5

NA: Industry code not used during the 1970 census.

<sup>a</sup>Relative risk adjusted for 5-year age group.

cancer, in women that reported employment during both 1960 and 1970.

## DISCUSSION

We surveyed all Swedish occupational and industrial groups and identified several groups that experienced elevated rates of ovarian cancer compared to other gainfully employed women. We used a report of employment in a specific occupation during both 1960 and 1970 as a surrogate marker for long-term exposure to that occupation. Women

that worked in specific occupations during both 1960 and 1970 were more frequently at elevated risk of ovarian cancer than were women that reported employment in those occupations during only one census, suggesting that long-term occupational exposures confer greater risk than short-term exposures.

We lacked data on lifestyle factors, such as parity and oral contraceptive use that may affect associations between occupational exposures and ovarian cancer. Consequently, the identified associations between occupations and industries may reflect lifestyle factors as well as specific

**TABLE III.** Relative Risk of Ovarian Cancer Associated With Occupational Physical Activity, Solvent Exposure, Pesticide Exposure, and County of Residence

Exposure	1970 only				1960 only				1960 and 1970			
	Cases	No. of women	RR <sup>a</sup>	95% CI	Cases	No. of women	RR <sup>a</sup>	95% CI	Cases	No. of women	RR <sup>a</sup>	95% CI
Physical Activity												
Sedentary	289	99,409	1.0 <sup>b</sup>		286	53,122	1.0 <sup>b</sup>		863	120,361	1.0 <sup>b</sup>	
Light	462	139,470	0.99	0.85–1.14	494	81,897	0.95	0.82–1.11	991	133,600	0.96	0.87–1.05
Medium	913	177,604	1.05	0.91–1.20	559	94,184	0.96	0.83–1.11	977	135,644	0.92	0.84–1.01
Heavy	884	152,918	1.07	0.94–1.23	332	51,486	0.95	0.81–1.12	648	88,229	0.94	0.85–1.04
Solvents (probability/intensity)												
Unexposed	2,542	558,374	1.0 <sup>b</sup>		1,640	284,509	1.0 <sup>b</sup>		2,965	391,218	1.0 <sup>b</sup>	
Low/low	450	113,884	0.91	0.82–1.01	192	34,751	0.95	0.82–1.10	536	83,257	0.88	0.81–0.98
Low/medium	13	5,923	0.74	0.43–1.27	17	3,677	0.81	0.50–1.31	45	7,805	0.84	0.63–1.13
Low/high	18	3,672	0.95	0.59–1.50	43	7,064	0.94	0.70–1.28	87	10,288	1.06	0.85–1.31
Med-high/low	79	24,548	0.87	0.70–1.09	59	11,615	0.97	0.74–1.26	172	22,699	1.08	0.93–1.26
Med-high/med	272	39,964	0.98	0.86–1.11	117	16,837	1.04	0.86–1.26	132	20,618	0.86	0.72–1.03
Med-high/high	48	8,658	1.02	0.76–1.35	50	6,797	1.11	0.84–1.48	114	14,350	0.99	0.82–1.20
Pesticides												
Unexposed	3,117	713,137	1.0 <sup>b</sup>		1,983	345,787	1.0 <sup>b</sup>		3,880	524,833	1.0 <sup>b</sup>	
Low	27	4,004	1.56	1.07–2.27	8	926	1.62	0.81–3.24	18	2,560	0.97	0.61–1.54
Medium	267	37,825	1.68	1.48–1.90	125	16,929	1.39	1.16–1.67	73	11,835	0.82	0.65–1.04
Medium/high	NA				NA				0	34		
High	NA				NA				59	6,680	1.23	0.95–1.59
County of residence												
Non-urban	2,256	473,426	1.0 <sup>b</sup>		1,184	217,886	1.0 <sup>b</sup>		2,084	307,121	1.0 <sup>b</sup>	
Urban	1,166	281,606	0.95	0.89–1.02	934	147,364	1.08	0.99–1.18	1,967	243,114	1.11	1.04–1.18

<sup>a</sup>Relative risk adjusted for 5-year-age group.<sup>b</sup>Referent group.

occupational exposures of women working in an occupation or industry.

Here, we compare the findings from our large study of ovarian cancer to previous findings for the most studied occupations in relation to ovarian cancer, as identified in a recent review [Shen et al., 1998]. The risk of ovarian cancer among dry cleaners has been studied extensively because of exposures to aromatic and chlorinated hydrocarbon solvents, but the accumulated evidence for an association is weak, with relative risk estimates ranging from 0.3 to 1.5 [Shen et al., 1998; Vasama-Neuvonen et al., 1999]. In this study, laundry work reported in 1960 and clothes pressing reported in 1970 were associated with significantly increased risks of ovarian cancer, based on 16 and 65 cases, respectively.

Women who work in graphics and printing industries have consistently experienced an increase in the risk of ovarian cancer in this and other studies, though our finding of a 60% elevation in risk in graphic workers and pictorial artists, designers, and decorators is somewhat less substantial than previous findings of greater than twofold elevations in risk [Shen et al., 1998; Bulbulyan et al., 1999].

We found that women working in healthcare were generally at decreased risk of ovarian cancer. However, it remains unclear whether healthcare workers are at increased risk of ovarian cancer, since previous findings, based on sufficient numbers of study subjects, are inconsistent with relative risks ranging from 0.5 to 2.2 [Hartge and Stewart, 1994; Sala et al., 1998; Shen et al., 1998; Petralia et al., 1999; Robinson and Walker, 1999]. Similarly, occupations involved in food preparation or foodservice were associated with an increased risk of ovarian cancer in this study, but previous studies of chefs, cooks, bar staff, and waitresses yielded inconsistent results [Shen et al., 1998]. The relation between agricultural work and ovarian cancer also remains unclear as previous studies have observed both elevated and decreased rates of ovarian cancer in various groups of agricultural workers [Wiklund and Dich, 1994; Sala et al., 1998; Shen et al., 1998; Settini et al., 1999]. In this study, horticulture and animal management workers in 1970 had a significant 11% lower rate of ovarian cancer than other workers. Conversely, there was a suggestion that long-term work in the gardening industry conferred an increased risk of ovarian cancer.

Our observation of decreased or similar rates of ovarian cancer among women employed in education relative to other workers is in agreement with some early findings [Hartge and Stewart, 1994; Shen et al., 1998], but is at odds with those of three recent studies, which observed 20% or greater excess mortality or incidence of ovarian cancer in teachers [Reynolds et al., 1999; Robinson and Walker, 1999]. Excess ovarian cancer among teachers is often attributed to delayed or decreased childbearing, and the differences in results across studies may reflect childbearing practices in various study populations.

Though not entirely consistent, previous studies suggest a slight excess of ovarian cancer in hairdressers and cosmetologists [Stavraky et al., 1981; Shen et al., 1998] that appears to wane in later cohorts, possibly because of tapering use of carcinogenic dyes over time [Pukkala et al., 1992; Boffetta et al., 1994]. In this study, there was a suggestion of a 20% increase among hairdressers and beauticians that worked in both 1960 and 1970, but those that worked in 1970 only were significantly less likely to have ovarian cancer than were other workers.

We identified several occupations associated with ovarian cancer risk in this and previous studies that have not been reviewed extensively. Our finding that work in the telegraph and telephone industry was associated with a significant 30% increased risk of ovarian cancer is in agreement with those of two previous studies that observed significant 30–40% increases in risk in such workers [Dosemeci and Blair, 1994; Sala et al., 1998].

In this study, women that worked in paper and packaging during both 1960 and 1970 experienced a significant, greater than twofold increase in ovarian cancer relative to women that worked in other occupations during those years. Increased incidence and mortality from ovarian cancer among paper workers has been consistently observed in previous studies as well [Costantini et al., 1994; Pukkala, 1995; Langseth and Andersen, 1999; Vasama-Neuvonen et al., 1999]. A study of paper and pulp workers showed that such workers were 50% more likely to have ovarian cancer than expected, with even greater risks among those that worked for 3 or more years, that were ages 25–30, or that worked in paper mills [Langseth and Andersen, 1999].

Our observation that textile workers were at increased risk of ovarian cancer is consistent with data from other studies [Costantini et al., 1994; Vasama-Neuvonen et al., 1999]. Our findings and those of others also suggest that shoe workers [Vasama-Neuvonen et al., 1999] and women that work in sawmills, planing mills, carpentry, and other lumber industries [Costantini et al., 1994] are significantly more likely to have ovarian cancer than other workers.

Specific etiologic agents that mediate increases in risk of ovarian cancer associated with various occupations identified in this and other studies are unknown. Though we did not specifically assess exposure to organic dusts, such as textile dust, leather dust, wood and paper dust, flour dust, and animal dust, the results of this and other studies indicate that such exposures may be involved in ovarian carcinogenesis. However, organic dusts were evaluated in a linkage study that used JEM and with the exception of leather dust, were unrelated to ovarian cancer risk [Vasama-Neuvonen et al., 1999]. Exposure to aromatic amines may be etiologically relevant as such exposure is common among shoe workers, graphic workers, and textile workers and has been associated with various types of cancer [Vineis and Pirastu, 1997].

We assessed the association between solvents and ovarian cancer using a JEM that estimated exposure to any solvent. Solvent exposure was unrelated to ovarian cancer risk in our study as well as another report [Hartge and Stewart, 1994]. However, the JEM in these studies did not measure exposure to specific solvents, but to all solvents. A third study assessed specific solvents and found an elevated risk of ovarian cancer associated with exposure to aliphatic and aromatic hydrocarbons [Vasama-Neuvonen et al., 1999]. A review of solvent use among occupations associated with ovarian cancer in our study also suggests that aliphatic and aromatic hydrocarbons may be etiologically important.

We used a JEM to study the relationship between pesticides and ovarian cancer because two previous studies showed that women exposed to triazine herbicides were at two- to fourfold increased risk of ovarian cancer relative to unexposed women [Donna et al., 1984, 1989]. Our results and those of another record-linkage study failed to identify a clear association between pesticide exposure and ovarian cancer [Vasama-Neuvonen et al., 1999], perhaps because the matrices missed associations limited to specific pesticides.

Despite previous suggestions that EMF [Heath, 1996], sunlight [Lefkowitz and Garland, 1994], and diesel [Vasama-Neuvonen et al., 1999] could influence the risk of cancer, we failed to observe associations between these exposures and ovarian cancer risk. Women who resided during 1960 and 1970 in the urban counties that contain the three largest cities in Sweden were at increased risk of ovarian cancer relative to women that resided in other counties, perhaps marking exposure not only to urban occupations, but also to urban pollution and lifestyle.

SES has been shown to be an determinant of ovarian cancer risk in the United States among non-Hispanic whites [Liu et al., 1998]. However, this study and another in Finland failed to reveal a difference in incidence rates by social class [Pukkala and Weiderpass, 1999], perhaps reflecting the reduced variability in social class within Nordic countries compared to the United States.

Physical activity has been hypothesized to decrease the risk of hormonally-related cancers such as ovarian cancer either through regulation of extraglandular formation of estrogens, influence on age at menarche, menopause or anovulation, enhancement of the immune system, or association with other healthy lifestyle habits [Kramer and Wells, 1996]. Women with greater leisure time activity have been shown to be both less likely [Frisch et al., 1985; Cotteau et al., 2000] and more likely [Mink et al., 1996] to experience elevated ovarian cancer risk than those with low levels of activity. Studies of occupational physical activity have also been ambiguous with both increased and decreased risks observed for greater sitting times and energy expenditures [Dosemeci et al., 1993; Zheng et al., 1993]. This study and two others [Pukkala et al., 1993; Vasama-Neuvonen et al., 1999] failed to observe an association between occupational physical

activity and the risk of ovarian cancer. A combined measure of leisure time and occupational physical activity may be necessary to discern the true relationship between physical activity and ovarian cancer risk.

The results of this study should be interpreted cautiously, since a large number of occupations and industries were surveyed and some of the associations may be due to chance. Job titles are imperfect measures of exposure to specific etiologic agents, and thus result in random misclassification of exposure. The use of JEM improves exposure classification, though some misclassification likely persists relative to the use of individual level data. The long and virtually complete follow-up of ovarian cancer occurrence, the size of the cohort, and the exposure assessment on two occasions 10 years apart are unique characteristics of this study. The prospective study design with reporting of occupations before the occurrence of cancer ensures that misclassification of exposure is non-differential.

In conclusion, these data provide support for an increased risk in women that work in dry cleaning, but fail to support previous assertions of increased risk in hairdressers. The relationships between ovarian cancer and work in healthcare, food-related work, agriculture, and education remain unclear, but available data suggest that if there is an increased risk of ovarian cancer associated with such work, it is unlikely to be substantial. The impact of leisure or occupational physical activity on ovarian cancer also remains elusive. Better measures of overall physical activity may be necessary for clarification. Telegraph and telephone, paper and paper packaging, and textile industries were associated with elevated ovarian cancer rates in this and previous studies and should be investigated more intensively. Finally, organic dusts, aromatic amines, aliphatic and aromatic hydrocarbons are suggested as potential etiologic agents for ovarian cancer.

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